

THE *CHEILANTHES MULTIFIDA* COMPLEX IN SOUTHERN AFRICA.

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The relation between *Cheilanthes multifida* Sw. and *C. Bolusii* Bak. has long been in doubt, especially since Sim's (1915) interpretation of the latter species. Even before the publication of the second edition of the "Ferns of South Africa" in 1915, Sim (1906) referred the more deltoid-fronded, as opposed to the oblong-fronded, section of this complex to *C. Bolusii* Bak.

In his synopsis of the genus *Cheilanthes*, Sim (1915) gives the following characters for the two species:

"*C. multifida*. Frond deltoid-oblong, usually twice as long as wide."

"*C. Bolusii*. Frond triangular, about as wide as long."

Furthermore, in his description of *C. Bolusii*, Sim (1915) writes, "Frond triangular, about as wide as long, four pinnatifid, three to six inches long, two to six inches broad", that is a length to breadth ratio of 1.5 to 1.0. Nevertheless he referred in the text to the specimen of *C. Bolusii* returned to Bolus from Kew after the wreck of the "Windsor Castle" and possibly drew his plate 106, fig. 2, from this frond (in the Bolus Herbarium). Both this specimen and his figure show frond laminae more than twice as long as the longest lowest pinnae (i.e. 2.6 and 2.4 times as long as the lowest pinnae respectively).

The figure accompanying the type description by Baker in Hooker's *Icones Plantarum*, t. 1636 (1886) shows a frond in which the lamina is 3.1 times longer than the lowest pinna. In addition, fronds of specimens collected at the type locality of *C. Bolusii*, i.e. the Darling Bridge over the Breede River, Worcester Div., Cape Province, by the author (*Schelpé* 4659, BOL) exhibit frond laminae 2.4 to 2.7 times as long as the lowest pinnae.

From this evidence it appears that *C. Bolusii* Baker is undoubtedly a synonym of *C. multifida* Sw. as previously suggested by Alston and Schelpe (1952).

Although Sim misapplied the name *C. Bolusii* to the more deltoid-fronded plants in the Transvaal and Southern Rhodesia, a critical examination of the relation of the population in these areas to the Cape Province and Natal populations of *C. multifida* has been considered necessary for the elucidation of this complex.

Sim (1915) intimated that the Transvaal and Rhodesian populations

included a greater proportion of deltoid-fronded individuals, and that the Cape Province and Natal populations generally exhibited a predominantly oblong frond lamina. This apparent difference between the two populations has prompted a statistical examination of the *C. multifida* complex. Since the main variable character between these populations appears to be the shape of the frond, the ratio between the length of the frond lamina and the length of the lowest pinna has been chosen for analysis. The wide variation in the proportion of dark to light coloured rhizome scales, even on single rhizomes, has precluded the use of this character in this discussion.

Another species which falls into that section of the Southern African Cheilanthes with glabrous fronds is *C. Dinteri* Brause. This plant is confined in its distribution to South West Africa as far as is known (Fig. 1). It can be separated from the *C. multifida* complex by its reddish rhizome scales and articulated pinnules.

ANALYSIS OF LAMINA SHAPE IN THE *C. MULTIFIDA* COMPLEX

Data on available specimens of *C. multifida* have been grouped primarily into Western Cape Province (west of 24 E. longitude), Eastern Cape Province (east of 24 E. long.), Natal, Transvaal, Southern Rhodesia and South West Africa. The secondary grouping is in districts proceeding eastwards in the Cape Province and northwards in Natal, Transvaal and Southern Rhodesia. Wherever possible, the locality, collector, collector's number and herbarium (abbreviation according to the Index Herbariorum, ed. ii) are cited for each specimen. The lamina length and lowest pinna length and the ratio between them is given for each frond measured. The analysis of the data is shown in Table I. Only complete fronds were measured, except in the small samples of Natal and Rhodesian specimens available, where some slightly incomplete fronds were measured. Imperfectly developed fronds have not been included.

		Lowest pinna length (cms.).	Lamina length (cms.).	Lamina/ lowest pinna ratio.
CAPE PROVINCE (WEST).				
CAPE PENINSULA:				
Cape Town, Oudekraal, Marloth 688b (PRE)	..	3.7	10.2	2.76
Cap. bon. spei, Alexander s.n. (PRE)	..	2.9	7.1	2.45
Lions Head, Michell s.n. (NBG)	..	2.0	6.8	3.40
Lions Head, Thode A175 (PRE)	..	2.5	7.2	2.88
Lions Head, Wolley Dod 2782 (BOL)	..	5.5	14.3	2.60
Spring Buttress, Marloth s.n. (PRE)	..	4.0	13.2	3.30
		4.2	10.4	2.48
Table Mountain, Rawson s.n. (SAM)	..	5.6	13.2	2.36

				Lowest pinna length (cms.).	Lamina length (cms.).	Lamina/ lowest pinna ratio.
MALMESBURY:						
Steenbergs Cove, <i>Compton 15920</i> (NBG)	..	..	..	2.1	6.4	3.05
Mamre Hills, <i>Compton 13762</i> (NBG)	..	..	..	3.1	10.7	3.45
PIQUETBERG:						
Langebaan, <i>Mathews s.n.</i> (NBG)	..	..	..	8.8	19.5	2.22
Piquetberg, <i>Zeyher s.n.</i> (SAM)	..	..	..	4.0	13.2	3.30
VAN RHYNSDORP:						
Van Rhyns Pass, <i>Taylor 2882</i> (NBG)	..	..	..	1.9	6.5	3.42
NAMAQUALAND:						
Lilyfontein, <i>Rodin 1440</i> (PRE)	..	..	..	1.9	4.9	2.58
PAARL:						
Paradise Kloof, <i>Adamson s.n.</i> (CT)	..	..	..	6.7	18.8	2.81
				6.3	19.2	3.05
Wemmershoek, <i>Esterhuysen 4078</i> (BOL)	..	..	..	3.2	7.6	2.38
Paarl Rock, <i>Steyn 51</i> (NBG)	..	..	..	4.8	10.4	2.17
WORCESTER:						
Bains Kloof, <i>Schlechter 9130</i> (PRE)	..	..	..	2.7	8.5	3.15
				2.9	8.5	2.93
Bains Kloof, <i>Schlechter 9130</i> (BOL)	..	..	..	3.6	9.0	2.50
Voetpadsberg, <i>Compton 17992</i> (NBG)	..	..	..	2.7	5.6	2.07
				1.8	4.1	2.28
Bains Kloof, <i>Schlechter 9130</i> (GRA)	..	..	..	3.4	8.1	2.38
CERES:						
Roggeveld Mtns., <i>Marloth s.n.</i> (PRE)	..	..	..	2.8	6.4	2.29
				3.1	7.9	2.55
Schwefteberg, <i>Esterhuysen 14729</i> (PRE)	..	..	..	2.9	6.9	2.38
Elandskloof, <i>Barker 3785</i> (NBG)	..	..	..	4.5	14.1	3.13
				3.6	11.5	3.19
Ceres, <i>Guthrie 3188</i> (NBG)	..	..	..	5.7	19.4	3.40
				5.4	14.7	2.72
TULBAGH:						
Tulbagh, <i>Pappe s.n.</i> (GRA)	..	..	..	3.0	8.6	2.87
				2.7	6.7	2.48
CLANWILLIAM:						
Scorpionsberg, <i>Barnard s.n.</i> (SAM)	..	..	..	2.9	9.7	3.34
				2.6	7.4	2.85
Pakhuis Pass, <i>Steyn 399</i> (NBG)	..	..	..	3.3	10.7	3.24
				3.2	8.9	2.78
Pakhuisberg, <i>Schlechter 8637</i> (GRA)	..	..	..	4.4	10.7	2.43
Clanwilliam, <i>Ecklon & Zeyher 76</i> (GRA)	..	..	..	3.6	8.9	2.47
Middelberg Plateau, <i>Compton 12722</i> (NBG)	..	..	..	5.0	11.7	2.34
				3.9	9.4	2.41

				Lowest pinna length (cms.).	Lamina length (cms.).	Lamina/ lowest pinna ratio.
MONTAGU:						
Kogmans Kloof, <i>Steyn 243</i> (NBG)	..	..	..	4.2	9.9	2.36
				3.8	8.9	2.34
Baden Kloof, <i>Compton 18343</i> (NBG)	..	..	..	7.1	14.4	2.03
LAINGSBURG:						
Constable, <i>Compton 9736</i> (NBG)	..	..	..	3.2	13.0	4.06
				3.2	12.9	4.03
Witteberg, <i>Compton 15221</i> (NBG)	..	..	..	4.3	8.2	1.91
				6.2	11.3	1.82
Whitehill Ridge, <i>Compton 13391</i> (NBG)	..	..	..	4.9	13.2	2.69
				1.8	2.9	1.61
				3.2	7.1	2.22
Whitehill Ridge, <i>Compton 5619</i> (NBG)	..	..	..	4.0	7.8	1.95
				4.1	9.3	2.27
Whitehill Ridge, <i>Barker 7813</i> (NBG)	..	..	..	3.2	6.1	1.91
				3.0	5.1	1.70
LADISMITH:						
Seven Weeks Poort, <i>Compton 7484</i> (NBG)	..	..	..	6.3	16.7	2.65
PRINCE ALBERT:						
Seven Weeks Poort, <i>Adamson s.n.</i> (CT)	..	..	..	5.0	13.5	2.70
				5.5	14.5	2.64
Seven Weeks Poort, <i>Thorne s.n.</i> (SAM)	..	..	..	3.5	9.7	2.77
CAPE PROVINCE (EAST).						
GRAAFF-REINET:						
Graaff-Reinet, <i>Bolus 329</i> (BOL)	..	..	..	14.4	25.5	1.77
SOMERSET EAST:						
Somerset East, <i>Bolus 329a</i> (BOL)	..	..	..	5.7	16.8	2.95
ALBANY:						
Amos Kloof, <i>Holland s.n.</i> (NBG)	..	..	..	12.2	28.6	2.34
				10.3	23.3	2.26
"Fairlands", <i>Killick 927</i> (PRE)	..	..	..	10.4	25.3	2.43
				8.5	22.5	2.65
Howiesons Poort, <i>Zeyher s.n.</i> (SAM)	..	..	..	5.6	17.5	3.13
QUEENSTOWN:						
Gwatyn, <i>Galpin 8199</i> (PRE)	..	..	..	5.5	14.3	2.60
KING WILLIAM'S TOWN:						
King William's Town, <i>Sim s.n.</i> (GRA)	..	..	..	3.8	11.4	3.00
King William's Town, <i>Sim s.n.</i> (PRE)	..	..	..	4.5	10.7	2.38
				2.2	5.8	2.64

					Lowest pinna length (cms.).	Lamina length (cms.).	Lamina lowest pinna ratio.
CATHCART:							
Toise River, <i>Acocks 9216</i> (PRE)	..	..	..	..	5·8	15·0	2·59
ST. MARKS:							
Main, <i>Young s.n.</i> (PRE)	..	..	..	..	1·7	4·1	2·41
XALANGA:							
Cala, <i>Young s.n.</i> (PRE)	..	..	..	..	5·1	13·8	2·71
					4·0	14·8	3·70
KOMGHA:							
Komgha, <i>Flanagan 1802</i> (GRA)	..	..	..	..	5·9	20·0	3·38
Komgha, <i>Flanagan 1802</i> (PRE)	..	..	..	..	4·8	19·5	4·06
LOCALITY UNPLACED:							
Redhill, <i>Rogers 11223</i> (GRA)	..	..	..	..	3·4	9·0	2·65
NATAL.							
ESTCOURT:							
Griffins Hill, <i>Acocks 11416</i> (PRE)	..	..	..	..	5·0	12·5	2·50
Tabamhlope, <i>Acocks 11459</i> (PRE)	..	..	..	..	3·3	7·6	2·30
					3·2	7·3	2·28
MTUNZINI:							
Ngoya, <i>Sim s.n.</i> (PRE)	..	..	..	..	1·9	4·2	2·21
VRYHEID:							
Vryheid, <i>McLoughlin 826</i> (PRE)	..	..	..	..	4·5	11·2	2·49
					5·3	16·8	3·17
LOCALITY UNPLACED:							
Highlands, <i>Schlechter 6842</i> (GRA)	..	..	..	..	9·2	20·5	2·23
TRANSVAAL.							
ERMELO:							
Dennebos, <i>Louw 1</i> (PRE)	..	..	..	..	4·0	10·4	2·60
Lake Chrissie, <i>Repton 1018</i> (PRE)	..	..	..	..	9·2	18·1	1·97
					9·0	16·8	1·87
CAROLINA:							
Carolina, <i>Moss & Rogers 1168</i> (PRE)	..	..	..	..	2·5	6·5	2·60
					3·8	5·4	1·42
					5·6	9·5	1·70
					5·3	9·2	1·74
PRETORIA:							
Erasmus Drift, <i>Bottomley s.n.</i> (PRE)	..	..	..	..	3·4	4·0	1·18
Hennops River, <i>Bosman s.n.</i> (PRE)	..	..	..	..	5·4	8·1	1·50
					4·6	6·6	1·43

					Lowest pinna length (cms.).	Lamina length (cms.).	Lamina/ lowest pinna ratio.
WITBANK:							
Klipfontein, <i>Mogg 12578</i> (PRE)	..	..	..	..	6.8	12.8	1.88
BELFAST:							
Belfast, <i>Doidge s.n.</i> (PRE)	..	..	..	..	11.7	15.6	1.33
					5.4	11.8	2.19
Van Brils Farm, <i>Bottomley s.n.</i> (PRE)	..	..	..	..	6.6	13.3	2.02
					5.8	10.8	1.86
BARBERTON:							
Barberton, <i>Thorncroft 31, 32</i> (PRE)	..	..	..	..	4.2	9.8	2.33
					4.8	8.2	1.71
Kaapsche Hoop, <i>V. Wager 83</i> (PRE)	..	..	..	..	4.6	6.8	1.48
					4.0	8.1	2.03
					4.4	8.6	1.95
Lomati Falls, <i>V. Wager 143</i> (PRE)	..	..	..	..	5.2	9.2	1.77
					2.2	5.4	2.45
Maid of the Mist, <i>Thorncroft 49</i> (PRE)	..	..	..	..	7.0	15.3	2.19
LYDENBURG:							
Branddraai, <i>Dyer 3964</i> (PRE)	..	..	..	..	4.1	6.2	1.51
Paardeplaats, <i>Pienaar 68</i> (PRE)	..	..	..	..	10.9	16.1	1.48
					8.3	14.1	1.70
PILGRIMS REST:							
Erasmus Kop, <i>Hardcastle 84</i> (PRE)	..	..	..	..	10.0	19.0	1.90
Kavyns Pass, <i>Schelppe 1654</i> (BOL)	..	..	..	..	7.5	18.5	2.47
Mt. Anderson, <i>Smuts s.n.</i> (PRE)	..	..	..	..	3.6	5.1	1.42
PIETERSBURG:							
Blaauwberg, <i>Esterhuysen 21284</i> (BOL)	..	..	..	..	7.7	14.2	1.84
LETABA:							
The Downs, <i>Junod 4040</i> (PRE)	..	..	..	..	2.5	3.6	1.44
The Downs, <i>Rogers 20135</i> (PRE)	..	..	..	..	9.5	15.0	1.58
ZOUTPANSBERG:							
Cyprus Point, <i>Junod 4068</i> (PRE)	..	..	..	..	5.1	9.7	1.90
					4.4	7.8	1.77
Piesanghoek, <i>Watson s.n.</i> (PRE)	..	..	..	..	8.2	14.2	1.73
LOCALITY UNPLACED:							
Makapans Poort, <i>Schlechter 4687</i> (GRA)	..	..	..	..	4.4	6.4	1.45
Makapans Poort, <i>Schlechter 4687</i> (PRE)	..	..	..	..	6.0	8.7	1.45
Six Miles Spruit, <i>Van Niekerk s.n.</i> (PRE)	..	..	..	..	4.2	5.8	1.38

SOUTHERN RHODESIA.

MATOPOS:

Matapos, <i>Borle 35</i> (PRE)	..	..	..	..	6.9	12.9	1.87
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					Lowest pinna length (cms.).	Lamina length (cms.).	Lamina/ lowest pinna ratio.
BULAWAYO:							
Bulawayo, <i>Eyles & Johnson 1019</i> (GRA)	..	..	..	..	12.1	22.0	1.82
VICTORIA:							
Glen Livet, <i>Mogg s.n.</i> (PRE)	..	..	..	..	11.5	19.2	1.67
MELSETTER:							
Between Cashel & Melsetter, <i>Schelppe 4023</i> (BOL)	..	..	..	..	7.0	13.5	1.93
UMTALI:							
Murakwas Hill, <i>Chase 3977</i> (PRE)	..	..	..	..	12.0	21.4	1.78
Umtali, <i>Holland s.n.</i> (NBG)	..	..	..	..	8.3	16.8	2.02
Umtali, <i>Chase 4519</i> (PRE)	..	..	..	..	19.7	37.4	1.90
Vumba, <i>Fisher 1624</i> (PRE)	..	..	..	..	4.0	7.8	1.95
INYANGA:							
S. of Rhodes Hotel, <i>Chase 4918</i> (PRE)	..	..	..	..	13.0	17.9	1.38
					13.1	25.5	1.95
MAZOE:							
Ironmask Hill, <i>Eyles 247</i> (BOL)	..	..	..	..	7.2	13.5	1.88
Mazoe, <i>Eyles 247</i> (PRE)	..	..	..	..	5.0	9.0	1.80
					3.9	7.6	1.95
NORTHERN RHODESIA.							
Dobeka Bridge, <i>Milne Redhead 3104</i> (PRE)	..	..	..	..	11.5	18.5	1.61
SOUTH WEST AFRICA.							
GROOTFONTEIN:							
Hoba Hills, <i>Schweickerdt 9345</i> (PRE)	..	..	..	..	3.6	5.7	1.58
					3.8	5.5	1.45
Otavi, <i>Dinter 5511</i> (BOL)	..	..	..	..	6.1	8.5	1.39
Otavi, <i>Dinter 5511</i> (PRE)	..	..	..	..	7.0	10.0	1.43

This data has been presented graphically in the series of histograms shown in Fig. 2. It will be seen that the ranges of variation in the lamina/lowest pinna ratios between the various populations in each geographical area overlap. However, the arithmetical mean ratios appear to fall into two groups, firstly those of the Eastern and Western Cape Province and Natal populations and secondly those of the Transvaal, Southern Rhodesian and South West African populations. The significance of these means has been tested as shown in Table I.



FIG. 1. Map showing the distribution of *C. multifida* (circles) and *C. Dinteri* (triangles) in Southern Africa.

TABLE I.—Analysis of data of lowest pinna length/lamina length ratios in *Cheilanthes multifida* populations in Southern Africa.

Region		Number of samples (n)	Mean ratio (m)	Standard deviation	Standard error (e)	$\frac{m_1 - m_2}{\sqrt{e_1^2 + e_2^2}}$
Western Cape	..	59	2.65	0.5276	0.0687	$\left. \begin{array}{l} 0.79 \\ 1.76 \\ 4.64 \\ 0.68 \end{array} \right\}$
Eastern Cape	..	18	2.76	0.5463	0.1218	
Natal ..	..	7	2.45	0.3366	0.1273	
Transvaal	..	38	1.80	0.3666	0.0587	
Southern Rhodesia	..	13	1.84	0.1656	0.0459	
South West Africa	..	4	1.46			
Northern Rhodesia	..	1	1.61			

From this evidence one may conclude that there is no significant difference in lamina/lowest pinna ratio between the populations in the Eastern and Western Cape Province and Natal on the one hand, and between the populations in the Transvaal and Southern Rhodesia on the other hand. However, there is a significant difference between the

ratios of the populations in Natal and the Transvaal, and an even greater significant difference between the ratios of the Western Cape Province and Transvaal populations in regard to this character.

Although very few specimens from South West Africa were available, the lamina/lowest pinna ratios of this population are much more comparable with those of the Transvaal and Southern Rhodesian populations than with the ratios in the Cape Province populations. The only Northern Rhodesian specimen seen has a lamina/lowest pinna ratio of 1.61, i.e. intermediate between the mean ratios of the South West African and Southern Rhodesian populations. Thus, on this character, the South West African population appears to belong to the Transvaal and Southern Rhodesian section and not to the Cape Province section of this species.

The distribution of *C. multifida* in Southern Africa (Fig. 2) shows it occurring in both winter and summer rainfall areas. In the drier and warmer regions within its distribution range it usually occurs only in

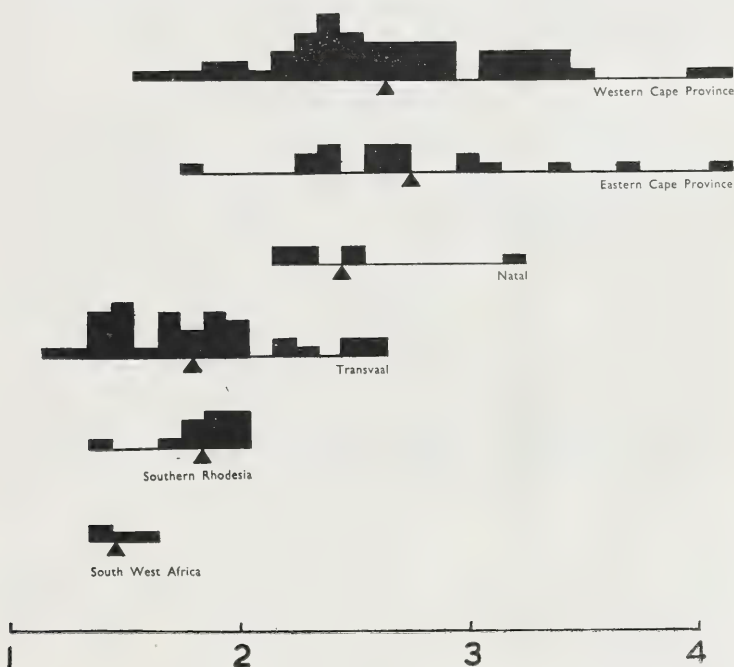


FIG. 2. Histograms of the frequency of specimens falling into 0.1 classes of lamina/lowest pinna length ratios in the populations of *Cheilanthes multifida*. A scale of ratios is given below; the mean ratio in each population is indicated by a triangle.

hilly or mountainous country where less desiccating conditions prevail. The known altitude limits of this species in the Western Cape Province are 1,000—5,000 ft., in Natal 4,000—5,800 ft. and in Southern Rhodesia 5,000—6,000 ft. It is almost invariably found in rock crevices or around boulders upon geological formations ranging from sandstones to dolomite. Although quite common in the South Western Cape Province, its general frequency decreases northwards from the Eastern Cape Province.

Consequently, it appears that a topocline exists within *C. multifida* ranging from the Western Cape Province, through the Eastern Cape Province, Natal, Transvaal, Southern Rhodesia and Northern Rhodesia to South West Africa.

Although on the available evidence the southern and northern populations within this species complex are significantly different in their lamina/lowest pinna ratios, the variations in this ratio in each geographical population largely overlap. Taking both these aspects into consideration, it is thought that the whole *C. multifida* complex is best treated as a single species, without the segregation of a separate variety.

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SUMMARY.

On analysis of frond shape (lamina length/lowest pinna length ratios) of populations of the *Cheilanthes multifida* complex, it appears that a topocline in this character exists in this species ranging from the Western Cape Province, through the Eastern Cape Province, Natal, Transvaal, Southern Rhodesia and Northern Rhodesia to South West Africa. *C. Bolusii* Bak. is synonymous with *C. multifida* Sw.

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